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LONGITUDINAL HEALTH RISKS AMONG GRADUATES AND
DISENROLLEES FROM DIVING SCHOOL(U) NAVAL HEALTH
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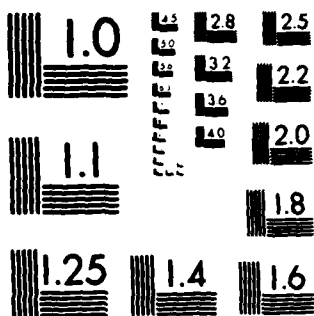
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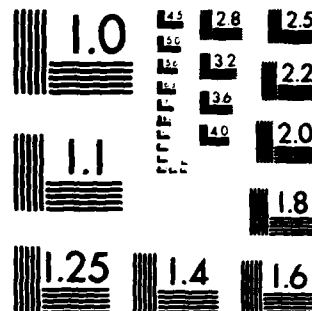
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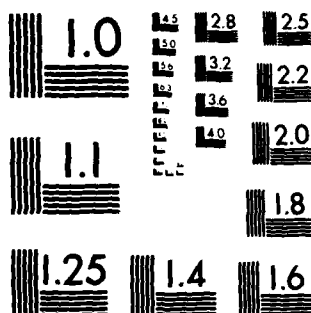
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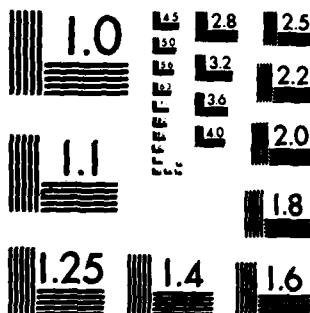
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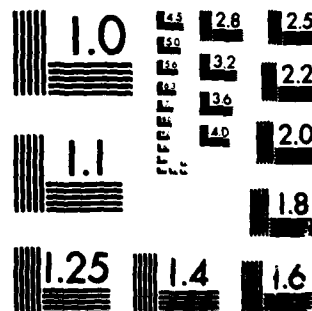
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**ENVIRONMENTAL HEALTH RISKS AMONG GRADUATES
AND DROPOUTS FROM DIVING SCHOOL**

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REPORT NO. 82-12

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Longitudinal Health Risks among Graduates and
Disenrollees from Diving School

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SUMMARY

Problem

Results of occupational health research suggest that most occupations, especially hazardous ones, involve a set of risks that can adversely affect the physical and mental well-being of individuals so employed. Failure to succeed in one's chosen field or in a training program also may negatively influence the individual's health. The primary objective of this study was to examine the health risks related to the hazardous occupation of diving. A secondary objective was to identify any adverse health effect that might be associated with failure to successfully complete a diver training program.

Objective

The specific objective of this study was to answer the following questions: (1) What are the health problems unique to graduates from diver training during a 13-year follow-up period? (2) What are the health problems of individuals who failed to successfully complete the diving course during a comparable follow-up? (3) What career phases present the greatest risk of illness or injury for both graduates and disenrollees?

Approach

Participants for this longitudinal study were 874 men assigned to the U.S. Navy Diving School (684 graduates and 190 disenrollees) during the time period 1964 to 1971. Data for this study were extracted from the NHRC career history computer file which contains demographic, service history, and medical information on all Navy enlisted personnel who served on active duty for any time period since July 1965. The following variables were selected from this file: date of reenlistment or separation from service, reason for separation, and primary diagnoses and dates of all hospitalizations. Annual hospital admission rates per 10,000 strength were computed for each of 16 major disease categories (ICDA-8) as well as for specific diagnoses associated with diving exposure or training failure. Populations at risk for graduates and disenrollees were determined by computing the number of men on active duty for each of the 13 postschool intervals and calculating the mid-point population value. For the 2-year preschool or baseline period, the proportions of hospitalized graduates and disenrollees were compared to determine if there was a significant difference between the two groups in morbidity experience prior to the extended medical follow-up. During the 13-year follow-up period, the primary objective was to establish whether or not total rates of hospitalizations as well as rates for specific diagnoses differed significantly between graduates and disenrollees. Comparative analyses of hospitalizations were conducted between groups across the 2-year postschool intervals to identify the most vulnerable time period for the occurrence of a serious disease.

Results

Results of a comparative test revealed that the proportion of graduates hospitalized (15.9%) during the preschool period did not differ significantly from the percentage (13.0) for hospitalized disenrollees ($z = 1.45$), which established an equitable baseline for the 13-year follow-up. Results of an analysis between graduates and disenrollees showed no significant difference in total hospitalization rates (831.6 versus 979.8, respectively) across the entire 13-year postschool period. Of the 20 or more disorders identified in the diving medicine literature, hospitalizations for only seven of these diagnoses were observed in this study: otitis externa, hearing disorders, pneumothorax, joint pain or arthralgia, oxygen or nitrogen toxicity, decompression sickness, and trauma or air embolism. Although graduates had a total of 10 hospitalizations for these disorders and disenrollees had no admissions, the X^2 value of 1.17 (with Yates correction) was statistically nonsignificant. In examining the annual hospitalization rates that were higher for disenrollees than graduates, one noteworthy difference was observed for the category of Mental Disorders ($X^2 = 12.8$; $p < .001$) in which the rate of alcohol/drug dependence was almost three times greater than that for the graduates ($X^2 = 9.6$; $p < .01$). None of the other disorders postulated as related to failure differentiated the disenrollees from the graduates.

In contrast to the 2-year preschool period, the first two years after the school experience represented a considerable

increase—nearly threefold for the disenrollees—in the percentage of the sample hospitalized (13.0% versus 34.2%). The graduate sample also had an increase in hospitalizations during this same 2-year period although the proportion of graduates hospitalized was significantly less than that for the disenrollees (34.2% for disenrollees versus 21.3% for graduates; $z = 3.25, p < .001$).

Conclusion

Results of comparisons between graduates and disenrollees showed that there was no significant difference between the two groups on hospitalizations for all diving-related disorders across the 13-year postschool period; graduates had 10 hospitalizations for these health problems as contrasted with none for the disenrollees. The relatively small sample size of this study as well as the effects of training, a youthful population, and available outpatient medical treatment probably account for the low hospitalization rates for diving-related disorders.

Of the disorders postulated as related to failure, the diagnosis of alcohol/drug dependence was the only one that resulted in a significantly higher hospitalization rate for disenrollees than graduates. The disenrollees' rate for this condition, moreover, was higher than that reported for the total Navy enlisted population. Further support for this association between failure and mental ill health (alcohol/drug abuse) was provided by the comparisons of hospitalizations by time interval. After establishing an equitable baseline in hospitalizations between graduates and disenrollees for the 2-year preschool period, the percentage of the disenrollees hospitalized in the first 2-year interval was shown to increase nearly threefold. Such results point up quite clearly that disenrollees experienced difficulties in effectively coping with the aftereffects of a school failure. Results of the present study suggest that failing to complete an occupational training program may represent a greater health risk to the individual in the short term than the health risks associated with the hazardous occupation itself.

Longitudinal Health Risks among Graduates and
Disenrollees from Diving School

Results of occupational health research suggest that most occupations in general, and hazardous ones in particular, involve a set of risks that can adversely affect the physical and mental well-being of individuals so employed. Failure to succeed in one's chosen field or in a training program also may negatively influence the individual's health. The primary objective of this study was to examine the health risks related to the hazardous occupation of diving. A secondary objective was to identify any adverse health effects that might be associated with failure to successfully complete a diver training program.

Diving is considered a high risk occupation because, while submerged, the diver must depend upon complex life-protection equipment and vigilant coworkers for life support (Linawcaver, 1977). The undersea environment presents many threats to safety and well-being, including hyperbaric exposures, inhalation of gas mixtures, extremes in temperature, sea turbulence and poor visibility, and equipment malfunction or failure. Each of these stressors can precipitate life-threatening conditions leading to medical emergencies and a physical or mental disorder.

At least 20 illnesses and injuries have been identified in the research literature as associated with these diving stressors (Bennett & Elliott, 1975). Although life threatening when the diver is submerged, the majority of these health-related problems are transient and the symptoms subside upon surfacing or shortly thereafter. Examples of these disorders and conditions include high pressure nervous syndrome, nitrogen narcosis, motion sickness or seasickness, vertigo, oxygen toxicity, and hypothermia (Bennett, 1976; Shilling et al., 1976; Hesser et al., 1978; Rostain et al., 1980). Other disorders, such as decompression sickness, the barotraumas, otitis externa, and hearing problems, require either inpatient or outpatient medical care (Berghage, 1976; Pullen et al., 1979). For at least one diving condition, dysbaric osteonecrosis, the disorder typically has a slow progression and is diagnosed primarily from viewing a radiograph months or years after the individual has begun his or her diving career (Davidson, 1981). The difficulty in determining the prevalence of dysbaric osteonecrosis is underscored by Hunter, Biersner, Sphar, and Harvey (1978) who report that only one of 16 positives in their study of 934 radiographically examined divers manifested overt symptoms attributable to this disease.

In this study, the health effects hypothesized to be related to a training failure also are examined; that is, health risks are identified among individuals who were assigned to a diver training program and then did not successfully complete it. In contrast to diving-related diseases, however, specific disorders attributed to failure per se have not been reported in the literature although research on stress-related diseases and on the relationship between illness incidence and the occurrence of major changes in an individual's life provide some insight into the health-related consequences of failure (Kasl & Cobb, 1966; Rahe et al., 1972).

The specific objective of this study was to answer the following questions: (1) What are the health problems unique to graduates from diver training during a 13-year follow-up period? (2) What are the health problems of individuals who failed to successfully complete the diving course during a comparable follow-up? (3) What career phases present the greatest risk of illness or injury for both graduates and disenrollees?

METHOD

Participants

Participants for this longitudinal study were 874 men assigned to the U.S. Navy Diving School in Washington, D.C., during the time period 1964 to 1971. Of the total, 684 men graduated from the diver training program and 190 failed to complete the course. During the 13-year follow-up, 582 enlistees were separated from service; by the end of the designated

time frame, there were 235 graduates and 57 disenrollees (34.4% and 30.0%, respectively) remaining on active duty.

Procedure

Data for this study were extracted from the career history computer file maintained at the Naval Health Research Center in San Diego. This file contains demographic, service history, and medical information on all Navy active duty enlisted personnel who served for any time period from July 1965 through December 1978. The following variables were selected from this file: date of reenlistment or separation from service, reason for separation, and primary diagnoses and dates of all hospitalizations. Date of entering diving school and outcome (graduation or disenrollment) were obtained from the diving school records.

All diagnoses were assigned a numeric code from the Eighth Revision International Classification of Diseases Adapted for Use in the United States (ICDA-8). This system consists of more than 5,000 specific diagnoses which have been grouped into 18 major diagnostic categories; two of these categories pertain to pregnancy-related and perinatal conditions and, therefore, were not included in this study.

Annual hospital admission rates per 10,000 strength were computed for each of the 16 major disease categories as well as for specific diagnoses associated with diving exposure or training failure. As reported in the diving medicine literature and noted above, the following disorders have been observed among the diving community: otitis externa, hearing problems, bradycardia, pneumothorax, dysbaric osteonecrosis, vertigo, dyspnea, immersion diuresis, hyperbaric arthralgia, hypercapnia, oxygen toxicity, nitrogen narcosis, venomous bite or sting, hypothermia, barotrauma (ear, sinus, pulmonary, gastrointestinal, or squeeze), decompression sickness, motion sickness, diving fatigue (excessive exertion), air embolism, and surgical emphysema. Because of the paucity of studies on the health-related effects of failure, the disorders associated with failure have been assumed to be similar to stress-related disorders: alcoholism, psychoses, neuroses, transient situational disturbance, cardiovascular disease, cerebrovascular disease, ulcers, and diabetes mellitus (Hoiberg, 1982). Populations at risk for graduates and disenrollees were determined by computing the number of men on active duty for each of the 13 postschool intervals and calculating the mid-point population value.

Hospitalizations were originally divided into 15 one-year intervals for both graduates and disenrollees--two for the preschool period and 13 for the postschool period. Because of the relatively few hospitalizations in many of the 15 time periods, the data were collapsed into 2-year intervals.

For the 2-year preschool or baseline period, the proportions of hospitalized graduates and disenrollees were compared to determine if there was a significant difference between the two groups in morbidity experience prior to the extended medical follow-up. It should be noted that the enlistees who entered diving school during the years 1964 through 1966 did not have complete preschool hospitalization data and, therefore, were deleted from the preschool baseline comparison (approximately 15% from each sample).

During the 13-year follow-up period, the primary objective was to establish whether or not total rates of hospitalization as well as rates for specific diagnoses differed significantly between graduates and disenrollees. In efforts to further assess the impact of being a graduate or a disenrollee, comparative analyses of hospitalizations (tests for significance between proportions) were conducted between groups across the 2-year postschool intervals. From the results of these comparisons, the most vulnerable time period for the occurrence of a serious disease (i.e., one requiring a hospitalization) among both graduates and disenrollees was determined.

RESULTS

Results of the test for the significance of differences between two proportions revealed that the proportion of graduates hospitalized (15.9%) during the preschool period did not differ significantly from the percentage (13.0) for hospitalized disenrollees ($z = 1.45$). This finding established an equitable baseline from which to conduct comparisons of hospitalization rates reported for the 13-year follow-up.

In Table 1 are presented the hospitalization rates for all admissions, the 16 major diagnostic categories, and several specific diagnoses that had relatively high rates within the 16 categories. Results of the comparative analysis between graduates and disenrollees showed no significant difference in total hospitalization rates (831.6 versus 979.8, respectively) across the entire 13-year postschool period. Comparisons between groups of the 16 major diagnostic categories yielded only one significant χ^2 value which is discussed in greater detail under the subheading "Failure-related Disorders."

Table 1
Annual Hospital Admission Rates by Major Disease Category and
Diving School Status during 13-Year Follow-Up Period

<u>Disease Category</u>	<u>Graduates</u>	<u>Disenrollees</u>
Accidents, Poisonings, and Violence	193.3 ^a	210.6
Fractures	60.4	73.3
Wounds, Contusions, Injuries	58.4	82.4
Dislocations, Strains, Sprains	38.3	36.6
Burns, Adverse Effects	36.2	18.3
Diseases of the Digestive System	104.7	91.6
Inguinal Hernia/Other Hernias	70.5	64.1
Diseases of the Musculoskeletal System	90.6	137.4
Internal Derangement/Other Diseases of Joint	28.2	45.8
Mental Disorders	68.5	174.0
Alcohol/Drug Dependence	38.3	109.9
Diseases of the Respiratory System	64.4	64.1
Symptoms and Ill-Defined Conditions	54.4	54.9
Infective and Parasitic Diseases	46.3	36.6
Diseases of the Skin and Subcutaneous Tissue	36.2	45.8
Cellulitis/Abscess	22.1	9.2
Diseases of the Circulatory System	36.2	36.6
Diseases of the Genitourinary System	32.2	54.9
Neoplasms	30.2	18.3
Supplementary Classifications	28.2	27.5
Diseases of the Nervous System and Sense Organs	28.2	9.2
Congenital Anomalies	12.1	9.2
Diseases of the Blood and Blood-Forming Organs	4.0	0
Endocrine, Nutritional, and Metabolic Diseases	2.0	9.2
Total Hospitalization Rate	831.6	979.8
Mean Number of Men	382	84

^a Hospitalization rates are numbers of admissions per 10,000 strength per annum.

Diving-related Disorders

Of the 20 or more disorders identified in the diving medicine literature, hospitalizations for only seven of these diagnoses were observed in this study: otitis externa, hearing disorders, pneumothorax, joint pain or arthralgia, oxygen or nitrogen toxicity, decompression sickness, and trauma or air embolism. The specific diagnosis with the highest hospitalization rate was decompression sickness with a rate of 8.0 per 10,000 strength while the rates were 2.0 for the other diag-

noses. Although graduates had a total of 10 hospitalizations for these disorders and disenrollees had no admissions, the χ^2 value of 1.17 (with Yates correction) was statistically nonsignificant.

Other specific diagnoses, which had not been identified as diving-related but had higher hospitalization rates for graduates than disenrollees, included viral hepatitis, neuritis/neuralgia, cataracts, bone neoplasia, and other nonspecific bone diseases. The reason these nonsignificant results are noted is that a possible association of these disorders with diving may be evidenced in a larger sample.

Failure-related Disorders

In examining the annual hospitalization rates that were higher for disenrollees than graduates, one noteworthy difference was observed for the category of Mental Disorders ($\chi^2 = 12.8$; $p < .001$) in which the rate of alcohol/drug dependence was almost three times greater than that for the graduates. A χ^2 value of 9.6 ($p < .01$) was obtained between the two groups for alcohol/drug dependence hospitalizations. None of the other disorders postulated as related to failure differentiated the disenrollees from the graduates. The potential ill aftereffects of failure, therefore, were concentrated in the category of Mental Disorders, notably alcohol/drug abuse. A substantially higher rate for disenrollees than graduates also was observed for the category of Diseases of the Musculoskeletal System although the difference was not significant.

Phase of Greatest Vulnerability for Ill Health

Table 2 presents the frequency distributions and hospitalization rates for several major diagnostic categories with the highest rates during the postschool follow-up intervals for graduates and disenrollees. The rates of admissions for each interval and the numbers of men remaining on active duty also are displayed in these tables.

In contrast to the 2-year preschool period, the first two years after the school experience represented a considerable increase--nearly threefold for the disenrollees--in the percentage of the sample hospitalized (13.0% versus 34.2%). The two categories of Mental Disorders and Accidents, Poisonings, and Violence accounted for almost 50% of the total number of hospitalizations for the disenrollees in the postschool period. The graduate sample also had an increase in hospitalizations during this same 2-year period although the proportion of graduates hospitalized was significantly less than that for the disenrollees (34.2% for disenrollees versus 21.3% for graduates; $z = 3.23$, $p < .001$). Of all intervals, the disenrollees experienced a highly significant elevation in hospitalizations during the first two years after failing diving school. Differences between samples on proportions of hospitalizations were nonsignificant for all of the other intervals.

DISCUSSION

The purpose of this longitudinal study was to compare the hospitalization rate for diving-related and failure-related disorders between graduates and disenrollees from the U.S. Navy diving school and to identify the time interval during a 13-year period when the risk of a serious illness (i.e., one requiring a hospitalization) was greatest.

Results of comparisons between graduates and disenrollees showed that there was no significant difference between the two groups on hospitalizations for all diving-related disorders across the 13-year postschool period; graduates had 10 hospitalizations for these health problems as contrasted with none for disenrollees. Because of the relatively small sample size of divers, the hospitalization rates for these disorders and for several others potentially associated with diving should be compared in a larger sample of divers and nondivers. Plans have been formulated to replicate this study with a large sample of Navy divers and controls. In addition to the specific diving-related disorders, the other illnesses to be compared are viral hepatitis, neuritis/neuralgia, cataracts, and diseases of the bone such as bone neoplasia and other nonspecific bone diseases. Also to be determined are the reasons for these higher rates which would substantiate or refute the following as diving-related: polluted water and viral hepatitis; inhalation of nitrogen and neuritis/neuralgia; cataracts and the combination of sun and water; and the other bone diseases as a sequela of dysbaric osteonecrosis.

Several explanations could be suggested for the relatively low hospitalization rates observed in this study among divers for diving-related disorders. First, these low rates may be a reflection of the effects of training: Navy divers are well

Table 2

Annual Hospital Admission Rates by Major Disease Category, Diving School Status, and Postschool Time Interval

GRADUATES

Disease Category (ICDA-8 Rubric)	POSTSCHOOL YEAR											
	1-2		3-4		5-6		7-8		9-10		11-12	
	Number of Cases	Rate ^a	Number of Cases	Rate	Number of Cases	Rate	Number of Cases	Rate	Number of Cases	Rate	Number of Cases	Rate
Accidents, Poisonings, and Violence	39	331.6	25	269.4	13	170.1	13	207.7	4	74.3	2	44.0
Diseases of the Digestive System	10	85.0	10	107.7	17	222.5	6	143.8	6	111.5	1	-
Diseases of the Musculoskeletal System	8	68.0	16	172.4	10	130.9	5	95.8	5	92.9	1	-
Mental Disorders	8	68.0	8	86.2	5	65.4	3	47.9	5	92.9	4	88.1
Diseases of the Respiratory System	4	34.0	12	129.3	6	78.5	6	111.8	3	55.7	1	-
Symptoms and Ill-defined Conditions	11	93.5	4	43.1	2	-	3	47.9	4	74.3	3	66.0
Other Diseases	45	382.6	28	301.7	23	301.0	11	175.7	12	223.0	5	110.1
Total Hospitalizations	125		103		76		49		39		17	
Mean Number of Men on Active Duty	588		464		382		313		269		227	
Total Hospitalization Rate		1062.9		1109.9		994.8		782.7		724.9		374.4

DISEMPOWERED

Disease Category (ICDA-8 Rubric)	POSTSCHOOL YEAR											
	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	17-18	19-20	21-22	23-24
	Number of Cases	Rate ^a	Number of Cases	Rate	Number of Cases	Rate	Number of Cases	Rate	Number of Cases	Rate	Number of Cases	Rate
Accidents, Poisonings, and Violence	13	436.2	3	147.0	0	0	4	285.7	2	-	1	-
Diseases of the Digestive System	3	100.7	3	147.0	1	-	1	-	1	-	1	-
Diseases of the Musculoskeletal System	6	201.3	5	245.1	1	-	1	-	1	-	1	-
Mental Disorders	10	335.6	3	147.0	4	238.1	2	-	0	0	0	0
Diseases of the Respiratory System	6	201.3	0	0	0	0	0	0	0	0	1	-
Symptoms and Ill-defined Conditions	1	-	1	-	1	-	2	-	0	0	1	-
Other Diseases	12	402.7	5	245.1	6	357.1	3	214.2	0	0	1	-
Total Hospitalizations	51		20		13		13		4		6	
Mean Number of Men on Active Duty	149		102		84		70		59		57	
Total Hospitalization Rate		1711.4		980.4		773.8		928.6		338.9		525.3

^aHospitalization rates are numbers of admissions per 10,000 strength per annum. Rates were not computed for categories with less than three cases.

trained and tend to have a low accident rate which probably corresponds with a low incidence of hospitalizations for injuries and illnesses (Berghage et al., 1975). Second, several disorders, such as dysbaric osteonecrosis, typically become symptomatic among older divers only after many months or years of diving. Because the men in this sample had an average age of less than 35 years, the rates for such disorders may not as yet be evidenced with current techniques of detection. Early detection techniques are currently being developed which will further our understanding of the prognosis and treatment of this disorder (Davidson, 1981). Third, many of the injuries and disorders receive immediate treatment at the diving site by medical personnel which reduces the need for hospitalization. Thus, the relatively small sample size of this study as well as the effects of training, a youthful population, and available outpatient medical treatment probably account for the low hospitalization rates for diving-related disorders.

Of the disorders postulated as related to failure, the diagnosis of alcohol/drug dependence was the only one that resulted in a significantly higher hospitalization rate for disenrollees than graduates. The disenrollees' rate for this condition, moreover, was higher than that reported for the total Navy enlisted population. The hospitalization rate for abuse of these substances was approximately 64 per 10,000 for all enlisted men as compared with 110 per 10,000 for the disenrollees (Hoiberg et al., 1981). In general, results of these comparisons suggested that failure may be implicated in the increased rate of hospitalizations for alcohol/drug dependence. However, it is equally plausible that prior alcohol/drug problems contributed to diving school failure.

Results of other comparisons, furthermore, indicated that failure is not associated with the general criterion of being hospitalized but seems to be related to specific disorders, i.e., alcohol/drug dependence. Compared with the total Navy population, rates generally were lower for both graduates and disenrollees with the exception of the disenrollees' elevated rate for alcohol/drug dependence. These lower overall rates probably are a reflection of the high physical standards established for diver training qualification. As with reactions to other training- or job-related stressors, the aftereffects of failure appear to be illness specific (Kasl & Cobb, 1966).

Further support for this association between failure and mental ill health (alcohol/drug abuse) was provided by the comparisons of hospitalizations by time interval. After establishing an equitable baseline in hospitalizations for graduates and disenrollees for the 2-year preschool period, the percentage of the disenrollees hospitalized in the first 2-year interval was shown to increase nearly threefold. Such results point up quite clearly that disenrollees experienced difficulties in effectively coping with the aftereffects of a school failure.

To conclude, the expanded longitudinal study currently under way on the total Navy diver population and a matched control sample is designed to identify the long-term health effects attributable to varying years of exposure to the diving environment. On the basis of this study, the Navy will be able to determine whether or not it is advantageous to develop special screening and intervention programs to protect the career diver's health. Results of the present study suggest that failing to complete an occupational training program may represent a greater health risk to the individual in the short term than the health risks associated with the hazardous occupation itself. In an effort to reduce the increased use of alcohol and drugs as a reaction to a training failure, the Navy might consider providing a special intervention program designed to help disenrollees successfully adjust to another Navy career path. The high costs of prevention in the short term always yield a significant pay-off through the long-term, low costs expended for health care.

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This longitudinal study examined the health risks associated (1) with the hazardous occupation of diving and (2) with failing to successfully complete a diver training program. Comparisons of annual hospitalization rates between graduates (n = 684) and disenrollees (n = 190) of the U.S. diving school revealed no significant differences in rates during the 2-year preschool, or baseline, period. During the 13-year follow-up, there were no significant differences between graduates and disenrollees in hospitalization rates for all diver-related diagnoses and for all other diag-		

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noses, with the exception of the significantly higher rate for alcohol/drug dependence among disenrollees than graduates. The time interval of greatest vulnerability for being hospitalized was during the first 2-year postschool period, especially for disenrollees who had a threefold increase in hospitalization rates from the preschool period. These results suggested that failing to complete an occupational training program represents a greater health risk to the individual than the health risks associated with the hazardous occupation itself.

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